PATENT ABSTRACTS OF JAPAN

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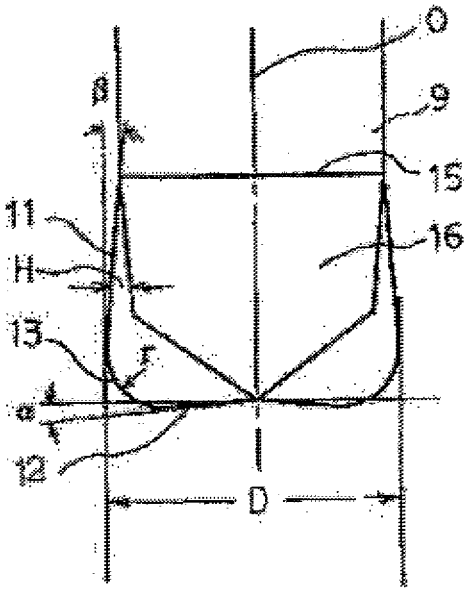
(54) END MILL OF SMALL DIAMETER FOR CUTTING CONTOUR LINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide the radius end mill of a small diameter by which contour line cutting can be used to perform deep cutting processing with high efficiency.
SOLUTION: This radius end mill is provided with a peripheral edge, an end cutting edge having a low and a medium gradient and an edge portion in which an edge with a corner R is formed at the connecting portion between these peripheral edge and end cutting edge, the peripheral edge is formed so that its rotating track can be made to be the track of an inversely tapered shape and the side angel of this inversely tapered shape is formed to be an angle in 3° to 30° .



CLAIMS

[Claim(s)]
[Claim 1]It is a radius end mill which has a corner R edge in a connection part of a peripheral cutting edge, an end cutting edge which has inside low inclination, and said peripheral cutting edge and said end cutting edge, An end mill for contour line cutting of a byway, wherein said peripheral cutting edge was formed so that the rotation locus might turn into a locus of reverse tapered shape, and it makes **** of said reverse tapered shape 3 degrees - 30 degrees.
[Claim 2]An end mill for contour line cutting of the byway according to claim 1 the degree of slope angle of low inclination [inside / of said end cutting edge] being 5 degrees - 20 degrees.
[Claim 3]An end mill for contour line cutting of the byway according to claim 1 or 2 characterized by setting a radius of said corner R edge to 0.05D-0.2D when a tool cutting diameter is set to D.
[Claim 4]An end mill for contour line cutting of the byway according to any one of claims 1 to 3 characterized by setting a path of edge Motobe of the shank side of said cutting part to 0.85-0.95D when a tool cutting diameter is set to D.
[Claim 5]said peripheral cutting edge and web thickness -- an end mill for contour line cutting of the byway according to any one of claims 1 to 4 setting to 0 the depth of a chip space which a part forms in the shank side trailer of an effective cutting length of said peripheral cutting edge.
[Claim 6]An end mill for contour line cutting of the byway according to any one of claims 1 to 5 characterized by **** of tapered shape of said neck being 5 degrees or less while being connected with a neck which has the tapered shape which the path expands in the direction of a shank gradually from edge Motobe of said shank side.
[Claim 7]An end mill for contour line cutting of the byway according to any one of claims 1 to 6, wherein a tool cutting diameter is 6 mm or less.
[Claim 8]An end mill for contour line cutting of the byway according to any one of claims 1 to 7 having burned and inserted a cutting part provided with said peripheral cutting edge, said end cutting edge, and said corner R edge in a shank or a neck, and joining to one by brazing or press fit.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]The end mill of a byway for this invention to perform ****** processing of a plastic metallic mold by high efficiency by contour line cutting, especially a cutting diameter are related with a radius end mill of 6 mm or less.
[0002]
[Description of the Prior Art]The end mill is provided with the peripheral cutting edge and the end cutting edge.
It is widely used for cutting of various kinds of metallic molds.
Since three-dimensional curved-surface processing is required in cutting of a metallic mold etc., the ball end mill has been used from the former. In recent years, efficient-ization of cutting comes to be required strongly and, as a result, the high-speed machine tool whose number of rotations is tens of thousands revolutions per minute and whose feed rate is a part for several meter/has spread. Since the definition of a contour part of a ball end mill is simple, NC programming has an advantage which can be created easily. However, since cutting speed does not occur, a rotation center part has the fault that uniform cutting ability is not obtained over the perimeter of a ball end cutting edge. Since, as for a ball end mill, the shaving remnants of the corner of the bottom of a metallic mold become large, the nose radius of a ball end mill cannot be set up greatly, but since it is related a tool diameter and directly, this nose radius also has the fault that influence comes out in the rigidity of the tool itself.
[0003]For this reason, in three-dimensional curved-surface processing of a metallic mold, it replaces with the above-mentioned ball end mill, and the radius end mill has also been used. A radius end mill is an end milling tool located in the middle of the square end mill which performs right-angled shoulder shaving, and the ball end mill which performs curved-surface processing. Since the radius end mill was carrying out interim form of a ball end mill and a square end mill, it was used as a cutting tool for R chamfering work, such as a metallic mold, but it is provided with the strong point in which impossible curved-surface processing can also be performed, with the square end mill. A radius end mill does not have a low speed near [the center of rotation which is a fault of a ball end mill] field, and can be used also for high-precision curved-surface processing. For this reason, high-speed-cutting processing by the number of highs rotational using a radius end mill is spreading widely by development of the machine tool and NC control software which control a principal axis like the latest MC (machining center). Especially in a plastic-molding public-funds type, highly efficient ****** processing has been strongly required about the rib groove where processing width is narrow and deep. As for cutting of such a rib groove, the radius end mill of a long picture of 6 mm or less is used for the byway, for example, a cutting diameter.
[0004]An example (JP,H11-90722,A, JP,H11-216609,A) of the general-purpose radius end mill used from the former is shown in drawing 8 and drawing 9. The radius end mill 1 shown in drawing 8 forms the end cutting edge 4 in the peripheral cutting edge 3 which has angle-of-torsion n with the tool spindle heart O on the side of the one end part of the shank 2, and the one end part of the shank 2, and forms the circular corner R edge 5 in the connection part of the peripheral cutting edge 3 and the end cutting edge 4 further. And the peripheral cutting edge 3 and the end cutting edge 4 are formed by about 2-6 sheets.
[0005]In order to reduce the cutting force of the end cutting edge 4 at the time of cutting, as shown in drawing 9, the end cutting edge 4 is formed so that it may have inside [of the angle alpha] low inclination to the line which intersects perpendicularly with the tool spindle heart O. Generally the angle alpha of low inclination [inside / of this] is formed in 1-2 degrees. Generally the length of the R section of the corner R edge 5 is formed in ** which becomes about 1/4 circle of the circle which this corner R part forms. In drawing 8, 6 is the chip space formed between the adjoining peripheral cutting edges 3. This chip space 6

is formed so that that depth of gullet may decrease from the end cutting edge 4 gradually to a shank 2-way, and it has the chip space 6a to which it extended in the direction of the shank 2 as some distance from the trailer by the side of the shank of the effective cutting length t of the peripheral cutting edge 3.
[0006]
[Problem to be solved by the invention]Sizing down of such a general-purpose radius end mill 1 is carried out as it is, a byway, especially a cutting diameter manufacture the radius end mill 1 of 6 mm or less by a long picture, and if contour line cutting performs ****** processing as shown in drawing 10, the following faults will occur. That is, the contact length of the workpiece 7 and each cutting part (a peripheral cutting edge, an end cutting edge, a corner R edge) becomes large, since the radius end mill 1 of a byway has small rigidity, it loses heart, and it becomes easy to generate vibration etc., and the danger of causing the fall of process tolerance and breakage of a cutting part arises. This Reason is as follows.
1) The cutting force which requires the angle alpha of low inclination [inside / of the end cutting edge 4] for the end cutting edge 4 by the contact length of the end cutting edge 4 and the workpiece 7 becoming large since it is small, 1-2 degrees and increases.
2) The cutting force which requires the length of the corner R edge 5 for the corner R edge 5 by the contact length of the corner R edge 5 and the workpiece 7 becoming large since it is large compared with a cutting diameter increases.
3) Since the peripheral cutting edge 3 is straight, the contact length of the peripheral cutting edge 3 and the workpiece 7 becomes large, and the cutting force concerning the peripheral cutting edge 7 increases.
Although the end mill which formed back taper in the peripheral cutting edge was also put in practical use, the amount of tapers was about 1/100 and a small value. In performing ****** processing especially, in order to process even the portion of a bottom by the same tool most, it must carry out from the beginning in the long amount of tool ejection which can process a tooth depth, and becomes easy to generate chatter vibration.
[0007]It is as follows when drawing 11 explains the Reason for the above in detail. When contour line cutting performs ****** using the radius end mill 1, the corner R edge 5 and the peripheral cutting edge 3 mainly contribute. Cutting stress F1 of the direction which intersects perpendicularly the cutting stress F concerning the radius end mill 1 with the tool spindle heart O at this time, If it decomposes into the cutting stress F2 of the direction of tool spindle heart O, as mentioned above, the length of the corner R edge 5 is greatly set to about 1/4 circle of the circle which this corner R edge 5 forms, and since the sake and the peripheral cutting edge 3 are not formed in moderate back taper form, they will be in the state of F1>F2. If contour line cutting is continued in the state of this F1>F2, since the radius end mill of a byway has small rigidity, chatter vibration will come to generate it.
[0008]As other conventional technologies, there is JP,H10-151513,A for which these people applied previously, for example. In the solid end mill which it has a cutting part at the one end, and an end mill given [the] in a gazette has a shank in the other end for the purpose of holding down the strength reduction of the end mill of a narrow diameter to the minimum, and has a taper part and a neck in the middle, The diameter of a neck is more slightly [than a cutting diameter] small, and it has a level difference in the connector of a cutting part and a neck, The connector of a taper part and a neck is used with the composition which does not have a level difference, and further, angle of torsion of a cutting edge shall be 5-20 degrees, the depth of a chip space is deep at the tip of a cutting edge, and inclination is provided in a chip space so that it may become 5% or less of cutting diameters by the back end.
[0009]However, in a long end mill in a byway, Since it was thin and long form, also in the end mill currently indicated by above-mentioned JP,H10-151513,A, it was few, and it is weak originally in intensity and it was [the improved effect of the intensity side was used for ****** processing of a rib groove etc. by contour line cutting and also] in the insufficient state. The place where it improves further at and this invention sets the above-mentioned conventional end mill as the purpose can be cut by a high speed and high delivery by contour line cutting in ****** processing which has three-dimensional curved surfaces, such as a metallic mold, and there is in a cutting diameter providing the radius end mill of a byway of 6 mm or less.
[0010]
[Means for solving problem]This invention is an end mill which has the cutting part which formed the corner R edge in the connection part of a peripheral cutting edge, the end cutting edge used as inside low inclination, and said peripheral cutting edge and said end cutting edge, Said peripheral cutting edge is formed so that the rotation locus may turn into a locus of reverse tapered shape, It is an end mill for contour line cutting of the byway which made **** of the reverse tapered shape of the locus 3 degrees - 30 degrees, This invention is an end mill for contour line cutting of the byway which made the degree of slope angle of low inclination [inside / of said end cutting edge] 5 degrees - 20 degrees, and the cutting

diameter of a cutting part applies it to a radius end mill of 6 mm or less, and it demonstrates an effect to contour line cutting. When the path of said cutting part is set to D, the radius of said corner R edge is an end mill for contour line cutting of the byway set to 0.05D-0.2D, and is an end mill for contour line cutting of the byway which set the path of edge Motobe of the shank side of said cutting part to 0.9D**0.05 further. the peripheral cutting edge formed in said cutting part and web thickness -- the depth of the chip space which a part forms is an end mill for contour line cutting of the byway which formed the chip space so that it might be set to 0 in the shank side trailer of the effective cutting length of said peripheral cutting edge. Said cutting part is an end mill for contour line cutting of the byway which made **** of the tapered shape of this neck 5 degrees or less while being the composition connected with the neck which has the tapered shape which that path expands in the direction of a shank gradually from edge Motobe of that shank side. It is the end mill for contour line cutting of a byway which burned and inserted the cutting part of the above composition in the shank or the neck, and was joined to one by brazing or press fit.

[0011]The Reason which limited the degree of half width of the back taper which the rotation locus of a peripheral cutting edge forms to 3 degrees - 30 degrees in this invention, It is because the length to which a peripheral cutting edge contacts the processed surface of a workpiece as it is less than 3 degrees becomes large, horizontal component F1 of the cutting stress F shown in drawing 11 becomes large as compared with the vertical component F2 and it becomes easy to generate chatter vibration. It is because the danger that cutting force will come to start a corner R edge too much, the intensity of a corner R edge will fall in the end mill of a byway, and a corner R edge will be damaged will arise if 30 degrees is exceeded. It is because the danger that the length to which an end cutting edge contacts the processed surface of a workpiece as it is less than 5 degrees will become large, cutting force of the Reason which limited the angle of low inclination [inside / of an end cutting edge] to 5 degrees - 20 degrees will increase, and a cutting diameter will damage the end mill of a byway of 6 mm or less arises. It is because the intensity of an end cutting edge will fall if 20 degrees is exceeded.

[0012]In this invention, when the cutting diameter of a cutting part is set to D, the Reason which limited the radius of the corner R edge to 0.05D-0.2D, 0. It is because the danger that a corner R edge will be damaged for the cutting force which the corner R edge became it small that it was less than 05D too much, and intensity fell, and was concentrated on this corner R edge at the time of contour line cutting arises. It is because the length to which a corner R edge contacts the processed surface of a workpiece will become large, it will lose heart at the time of contour line cutting and it will become easy to generate vibration, if 0.2D is exceeded.

[0013]a time of setting a cutting diameter of a cutting part to D in this invention -- heel by the side of a shank of a cutting part -- a Reason which limited a path of a part to 0.9D**0.05 is less than 0.85D -- this heel -- a path of a part becomes small too much -- heel of a lever -- intensity of a part falls -- heel -- it is because a danger of damaging from a part arises. It is because cutting force which starts a peripheral cutting edge by an angle of back taper of a peripheral cutting edge becoming small inevitably, and length to which a peripheral cutting edge contacts a processed surface of a workpiece becoming large will increase if 0.95D is exceeded.

[0014]In this invention, when a neck of tapered shape is connected with a cutting part, a Reason **** of tapered shape of this neck was 5 degrees or less is that there is a possibility of interfering with a workpiece when 5 degrees is exceeded. a peripheral cutting edge formed in a cutting part and web thickness -- the depth of a chip space which a part forms, a Reason it was presupposed that was referred to as 0 in the shank side trailer of an effective cutting length of a peripheral cutting edge -- this chip space -- going up -- it is because a cross-section area of a neck decreases, intensity falls and this danger of going up and damaging from a part produces an end mill of a byway.

[0015]

[Mode for carrying out the invention]Hereafter, an embodiment of the invention is described. Drawing 1 is a front view showing a 1st embodiment of an end mill for contour line cutting of a byway of this invention. In drawing 1, the radius end mill 8 (henceforth the end mill 8) of a byway of this invention comprises the shank 9 and the cutting part 10. The cutting part 10 comprises the peripheral cutting edge 11 formed in a side outer peripheral part of the cutting part 10, the end cutting edge 12 formed in an end face of the cutting part 10, and the circular corner R edge 13 formed in a connection part of the end cutting edge 12 and the peripheral cutting edge 11. 2-6 numbers of cutting teeth of the end cutting edge 12 are formed. 14 is the chip space formed between the adjoining peripheral cutting edges 11. Construction material of the end mill 8 is made into products made from cemented carbide, such as a WC-Co system adopted from the former, and forms a suitable wear-resistant enveloping layer for the cutting part 11.

[0016]As the end mill 8 of this invention is shown in drawing 2, the rotation locus of the peripheral cutting edge 11 forms a back taper in a peripheral cutting edge so that the direction of tool spindle heart O and

the angle (**** of a taper) beta to make may be 3–30 degrees. Thus, since the length which the peripheral cutting edge 11 hits with a workpiece as aforementioned becomes short when performing contour line cutting by forming a back taper with an angle of 3–30 degrees in the peripheral cutting edge 11, the cutting force concerning the cutting part 10 can decrease, and can control generating of chatter vibration of the end mill 8.

[0017]As furthermore shown in drawing 2, the end cutting edge 12 is formed so that it may have low inclination, while the degree alpha of slope angle to the tool spindle heart O and rectangular **** will be 5 degrees – 20 degrees. contour line cutting on the same flat surface is completed -- the direction of tool spindle heart O -- the end mill 8 -- ** -- when sending a fixed quantity and starting contour line cutting of the next flat surface, the end cutting edge 12 performs the operation as a cutting edge. At this time, damage to the end cutting edge 12 and a crease of the end mill 8 can be prevented by that which can make small cutting force which starts in the direction of tool spindle heart O of the end mill of a byway by providing low inclination in the end cutting edge 12, while the angles alpha are 5 degrees – 20 degrees.

[0018]Intensity is prevented from making it d set to 0.85–0.95D, and edge Motobe's 15 path d becoming small too much, and falling when the path of edge Motobe 15 who connects D, the cutting part 10, and the shank 2 for the path of the cutting part 10 is set to d, as this invention is shown in drawing 2. It is important to make small the value of horizontal component F1 of the cutting stress which the cutting force where a cutting diameter makes the radius r of the corner R edge 13 as small as possible to the cutting diameter D, and which requires it for the corner R edge 13 in the end mill of a byway of 6 mm or less is decreased, and is shown in drawing 11. In an end mill of 6 mm or less, the radius r of the corner R edge 13 has a good cutting diameter of this invention to form so that it may be set to 0.05D–0.2D.

[0019]in drawing 2 -- H -- the peripheral cutting edge 11 and web thickness -- the depth of gullet of the chip space 14 which the part 16 forms is expressed. In this invention, this depth-of-gullet H is formed so that it may be substantially set to 0 in the shank side trailer of the effective cutting length t of the peripheral cutting edge 11, as shown in drawing 3. That is, the peripheral cutting edge 11 goes up and the chip space 14 is made into the structure which is not extended and established at the part k. Since reduction of an about [edge Motobe 15] tool diameter can be prevented by forming the chip space 14 of such composition, a cutting diameter can prevent the fall of the rigidity of an end mill of 6 mm or less. Although a chip space processes setting the above-mentioned depth-of-gullet H to 0 substantially in the shank side trailer of the effective cutting length t of the peripheral cutting edge 11 using a diamond wheel etc., A cutting diameter means that this processing operation includes the error of some groove processing in order to require advanced processing technology with the end mill of a byway of 6 mm or less.

[0020]Then, a 2nd embodiment of this invention is described based on drawing 4. The end mill 17 which is a 2nd embodiment shown in drawing 4 forms the neck 18 of tapered shape between the shank 9 and the cutting part 10, although the composition of the cutting part 10 is the same as that of a 1st embodiment shown in drawing 1. This neck 18 is made into form which that path expands in the direction of a shank gradually from edge Motobe 15 as shown in drawing 5. And it is made for the angle theta (**** of a taper) which the neck 18 makes with the direction of tool spindle heart O to be 5 degrees or less. By forming this neck 18, interference with a workpiece is avoided, and although it is an end mill of a byway, the end mill of the long picture to which rigidity is not reduced can be provided.

[0021]Then, a 3rd embodiment of this invention is described based on drawing 6 and drawing 7. This 3rd embodiment manufactures separately the cutting part 10 which has the lobe 19, in the example shown in drawing 6, burns and inserts this cutting part 10 in the pore 20 formed in the one end part of the shank 9, and joins it to the shank 9 by brazing or press fit at one. In the example similarly shown in drawing 7, the cutting part 10 is burned and inserted in the pore 21 formed in the one end part of the neck 18, and it joins to the neck 18 by brazing or press fit at one. In this 3rd embodiment, since only the cutting part 10 can be manufactured by WC–Co system cemented carbide and the shank 9 and the neck 10 can be manufactured with tool steel, cost reduction of the end mill of this invention can be performed.

[0022]

[Working example](Embodiment 1) While manufacturing the radius end mill which are the 1st example 1 of this invention shown in drawing 1 – drawing 3, and a conventional example shown in drawing 8 and checking the cutting state, the comparative test of the tool life was done. The peripheral cutting edge was formed in the example 1 of this invention so that that rotation locus might become reverse tapered shape, and **** of this reverse tapered shape made it it with 10 degrees. This reverse tapered shape was not established in a conventional example. About the degree of slope angle of low inclination [inside], the example of this invention was 2 degrees by 8 degrees and a conventional example. Both sides set the path (cutting diameter D) of the cutting part to 3 mm. About the radius of the corner R edge, the example 1 of

this invention was set to 0.3D (0.9 mm) by 0.1D (0.3 mm) and a conventional example. the heel by the side of a shank — making it the example 1 of this invention set to 0.9D (2.7 mm) as for the path of a part -- a peripheral cutting edge and web thickness -- about the depth of the chip space which a part forms, the example 1 of this invention and the conventional example were set to 0 in the shank side trailer of an effective cutting length. Both sides made construction material of the cutting part the product made from WC-Co system cemented carbide, and it covered the rigid film of TiAlN with the product made from superparticle cemented carbide of hardness 92HRA with each edge. And construction material of the workpiece was made into S55C material, a depth of 30 mm and the form of the wall surface consisted of a flat surface and a curved surface, and the inclination of each wall surface performed ****** processing with a pocket form of 3 degrees and 5 degrees.

[0023]Number-of-rotations 10000min^{-1}, feed-rate 500 mm/min, 0.2 mm of tool axial direction slitting, and the amount of tool ejection are 36 mm which hits by 12 times the tool diameter, and the cutting condition performed semi dry processing by mist by contour line cutting. As a result, the example 1 of this invention can perform cutting which loses heart to a depth of 30 mm, and vibration does not almost have, either, and was stabilized, and is a normal tool wear form.

It was in the state which can still be cut.

The peripheral cutting edge lost heart from a depth of 1 mm in contact with a workpiece, vibration occurred, a conventional example is 3 mm in depth, and chipping has already produced it with the corner R edge.

It broke in the knot of a cutting part and a neck in the middle of 10-mm-deep processing, and became a life.

[0024]What changed **** of the reverse tapered shape of the peripheral cutting edge of (Embodiment 2), next the example 1 of this invention to 2 degrees, 3 degrees, 5 degrees, 10 degrees, 15 degrees, 20 degrees, 30 degrees, and 40 degrees was manufactured as the examples 2-9 of this invention, and the comparative test was done. Although all the tools were processible to a depth of 30 mm, That whose **** of reverse tapered shape is 2 degrees has the intense wear including chipping of a peripheral cutting edge, lose heart from the hit beyond a depth of 20 mm, vibration occurs, and **** what is 40 degrees, It was in the state where are a time of producing chipping with a corner R edge and processing it into it to a depth of 30 mm per depth of 2 mm, and the tool life is already reached. They were good cutting states, and as for all the things whose **** of this reverse tapered shape are 3 degrees - 30 degrees, that especially whose **** of a back taper are 10 degrees - 20 degrees was stabilized, and they were good cutting states.

[0025]What changed the degree of slope angle of low inclination [inside / of the end cutting edge of (Embodiment 3), next the example 1 of this invention] to 3 degrees, 5 degrees, 10 degrees, 15 degrees, 20 degrees, and 25 degrees was manufactured as the examples 10-15 of this invention, and the comparative test was done. Although all the tools were processible to a depth of 30 mm, That whose inside [of an end cutting edge] low inclination is 3 degrees has a little large wear of an end cutting edge, it loses heart from the hit beyond a depth of 10 mm, vibration occurs, and minute chipping began to have produced that whose inside [of an end cutting edge] low inclination is 25 degrees with an end cutting edge and a corner R edge from the hit beyond a depth of 7 mm. All the things in which this degree of slope angle is 5 degrees - 20 degrees were good cutting states, and especially the thing whose inside [of an end cutting edge] low inclination is 10 degrees - 20 degrees was stabilized, was a good cutting state, and was a normal and very small wear form.

[0026]The examples 16-20 of this invention which changed the radius of the corner R edge of (Embodiment 4), next the example 1 of this invention which set the cutting diameter D to 3 mm to 0.03D, 0.05D, 0.15D, 0.20D, and 0.25D were manufactured, and the comparative test was done. Although all the tools were processible to a depth of 30 mm, As for the thing of 0.03D, the radius of the corner R edge produced minute chipping from per depth of 10 mm with the corner R edge, and in the radius of the corner R edge, the depth lost heart from per 20 mm, vibration occurred, and, as for the thing of 0.25D, the peripheral cutting edge and the corner R edge showed the chipping precedence type wear form. It is the cutting state in which the radius of the corner R edge was stabilized to a depth of 30 mm as for the thing of 0.05D, 0.15D, 0, and 20D.

It was a normal and very small wear form.

[0027]It manufactured like [example / which made 3 degrees **** of tapered shape of (Embodiment 5) next said drawing 4, and a neck shown in drawing 5] said test, and a comparative test was done. Stable

cutting which cutting ability becomes good, can control chipping, and also does not have chatter vibration about a case where the neck 18 is formed, either was possible.

[0028]

[Effect of the Invention]In this invention explained above, the contact length of a workpiece, and a peripheral cutting edge, an end cutting edge and a corner R edge becomes short at the time of cutting. Therefore, while a high speed and high delivery cutting are especially attained by contour line cutting in ****** processing of a metallic mold etc., the high cutting diameter of a tool life can provide the radius end mill of a byway of 6 mm or less.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]Drawing 1 is a whole front view showing a 1st embodiment of this invention.
[Drawing 2]Drawing 2 is an enlarged drawing showing the rotation locus of the cutting part shown in drawing 1.
[Drawing 3]Drawing 3 is an enlarged drawing of the cutting part shown in drawing 1.
[Drawing 4]Drawing 4 is a whole front view showing a 2nd embodiment of this invention.
[Drawing 5]Drawing 5 is an enlarged drawing showing the rotation locus of the cutting part shown in drawing 4.
[Drawing 6]Drawing 6 is a whole front view showing a 3rd embodiment of this invention.
[Drawing 7]Drawing 7 is also a whole front view showing other embodiments of a 3rd embodiment.
[Drawing 8]Drawing 8 is a whole front view showing the conventional radius end mill.
[Drawing 9]Drawing 9 is an enlarged drawing of the cutting part of drawing 8.
[Drawing 10]Drawing 10 is an explanatory view for explaining how to perform contour line cutting using an end mill.
[Drawing 11]Drawing 11 is an explanatory view for explaining a cutting state of stress when contour line cutting is performed using the conventional radius end mill.
[Explanations of letters or numerals]
1 Radius end mill
2 Shank
3 Peripheral cutting edge
4 End cutting edge
5 Corner R edge
6 6a Chip space
7 Workpiece
8 Radius end mill
9 Shank
10 Cutting part
11 Peripheral cutting edge
12 End cutting edge
13 Corner R edge
14 Chip space
15 Edge Motobe
16 web thickness -- a part
17 End mill
18 Neck
19 Lobe
20 and 21 Pore

[Translation done.]